Master project, 2018-2019

— Energy production sharing between Power-Electronics and Synchronous Machines —

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Context

In the context of high integration of modern Renewable Energy Systems (RES) on the Power-Grid [1], this project focusses on the interactions between the traditional generators, i.e. {turbine, synchronous machine}, and these systems. During last decades, RES, such as wind or solar power plants, have been integrated to the grid using as fundamental assumption that the grid behaved as an infinite voltage source, able to keep control on voltage magnitude and frequency whatever the integrated RES power. This assumption led to the typical today's RES control technics, designed such as the power electronics converter at interface between the renewable energy source and the grid behaves as a current source from the grid point of view. This control mode, mentioned as "Current Control Inverter (CCI)" mode, or "Grid-Feeding" mode, or "Grid-Following" mode in Literature becomes problematic since overall renewable energy production capacity becomes more and more close to the capacity of traditional electricity generation systems [2]. To guaranty grid stability in case of further RES integration, recent works have been launched to build new grid codes [3]. One consequence is the introduction of new services to be ensured by power electronics converters, participating now to the voltage stability control. L2EP grid team participates to this research work, developing jointly with industrial partners such as EDF or RTE new control technics to operate in "Voltage Control Inverter (VCI)" mode, also called "Grid-Forming" mode [4]. However, until now, this work has been carried out with a simplified model of the grid, in which the synchronous machine dynamics are neglected. In order to understand more precisely the interactions between the synchronous generators and the power electronics converters, a Ph.D. is ongoing and the first results highlighted the control stability limit when increasing the power of a converter configured in Current Control Inverter (CCI) mode.

Objective and Work steps

This project reinforces an ongoing Ph.D. work. It consists in leading a control stability analysis when the converter operates in Voltage Control Inverter (VCI) mode, producing energy on the grid jointly with a synchronous machine (Figure 1).

The building block models of inverter and machine are available, as well as the analysis tools. The work consists in updating the simulation environment to the voltage control mode and to compare the stability limits with the case when the converter operates in CCI mode.

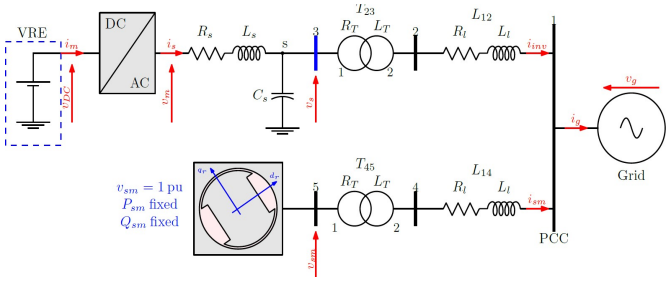

Figure 1: A synchronous machine and a power electronics converter jointly participate to energy production on power grid

Key word

Transmission grid, small-signal analysis, current control inverter, voltage control inverter, synchronous generator

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[3] ENTSO-E, 'High Penetration of Power Electronic Interfaced Power Sources (HPoPEIPS) ENTSO-E Guidance document for national implementation for network codes on grid connection', Brussels, Tech. Rep. March, 2017, p. 37
[4] G. Denis, "From grid-following to grid-forming: The new strategy to build 100 % power-electronics interfaced transmission system with enhanced transient behavior", L2EP laboratory, Centrale Lille, 2017